CLAIMS

1. A nonvolatile magnetic memory device of the type having:

a first wiring;

a second wiring intersecting three-dimensionally with said first wiring; and

a tunnel magnetoresistance element which is electrically insulated from said first wiring and electrically connected to said second wiring and which is formed in the region of intersection of said first wiring and said second wiring such that a tunnel insulating layer is sandwiched between ferromagnetic materials which change in resistance depending on whether the spin direction is parallel or antiparallel, thereby recording information; wherein

said magnetic memory device comprises a magnetic flux concentrator of high-permeability layer formed at least on the lateral sides of said first wiring and on the side of said first wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layer formed on the lateral sides of said first wiring projecting from said first wiring toward said tunnel magnetoresistance element.

2. The magnetic memory device as defined in Claim 1, wherein the magnetic flux concentrator has the high-permeability layer formed also on the surface of the first wiring close to the tunnel magnetoresistance element.

3. The magnetic memory device as defined in Claim 1, wherein an insulating film is formed between the magnetic flux concentrator and the first wiring.

4. The magnetic memory device as defined in Claim 3, wherein the magnetic flux concentrator has the high-permeability layer formed, with an insulating film interposed, also on the surface of the first wiring close to the tunnel magnetoresistance element.

5. A nonvolatile magnetic memory device of the type having:

a first wiring;

a second wiring intersecting three-dimensionally with said first wiring; and

a tunnel magnetoresistance element which is electrically insulated from said first wiring and electrically connected to said second wiring and which is formed in the region of intersection of said first wiring and said second wiring such that a tunnel insulating layer is sandwiched between ferromagnetic materials which

change in resistance depending on whether the spin direction is parallel or antiparallel, thereby recording information; wherein

said magnetic memory device comprises a magnetic flux concentrator of high-permeability layer formed at least on the lateral sides of said second wiring and on the side of said second wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layer formed on the lateral sides of said second wiring projecting from said second wiring toward said tunnel magnetoresistance element.

6. The magnetic memory device as defined in Claim 5, wherein the magnetic flux concentrator has the high-permeability layer formed also on the surface of the second wiring close to the tunnel magnetoresistance element.

7. The magnetic memory device as defined in Claim 5, wherein an insulating film is formed between the magnetic flux concentrator and the second wiring.

8. The magnetic memory device as defined in Claim 7, wherein the magnetic flux concentrator has the high-permeability layer formed, with an insulating film interposed, also on the surface of the second wiring

close to the tunnel magnetoresistance element.

9. A nonvolatile magnetic memory device of the type having:

a first wiring;

a second wiring intersecting three-dimensionally with said first wiring; and

a tunnel magnetoresistance element which is electrically insulated from said first wiring and electrically connected to said second wiring and which is formed in the region of intersection of said first wiring and said second wiring such that a tunnel insulating layer is sandwiched between ferromagnetic materials which change in resistance depending on whether the spin direction is parallel or antiparallel, thereby recording information; wherein

said magnetic memory device comprises a magnetic flux concentrator of high-permeability layer formed between said first wiring and said tunnel magnetoresistance element and on the lateral sides of said tunnel magnetoresistance element, with an insulating film interposed.

10. A nonvolatile magnetic memory device of the type having:

a first wiring;

a second wiring intersecting three-dimensionally with said first wiring; and

a tunnel magnetoresistance element which is electrically insulated from said first wiring and electrically connected to said second wiring and which is formed in the region of intersection of said first wiring and said second wiring such that a tunnel insulating layer is sandwiched between ferromagnetic materials which change in resistance depending on whether the spin direction is parallel or antiparallel, thereby recording information; wherein

said magnetic memory device comprises a first magnetic flux concentrator of high-permeability layer formed at least on both of the lateral sides of said first wiring and on the side of said first wiring which is opposite to the side facing said tunnel magnetoresistance element and a second magnetic flux concentrator of high-permeability layer formed between said first wiring and said tunnel magnetoresistance element and on the lateral sides of said tunnel magnetoresistance element, with an insulating film interposed.

11. The magnetic memory device as defined in Claim 10, wherein an insulating film is formed between the

first magnetic flux concentrator and the first wiring.

12. The magnetic memory device as defined in Claim 8, wherein at least either of the high-permeability layers formed on the lateral sides of the first wiring projects from the first wiring toward the tunnel magnetoresistance element.

13. The magnetic memory device as defined in Claim 12, wherein an insulating film is formed between the first magnetic flux concentrator and the first wiring.

14. A nonvolatile magnetic memory device of the type having:

a first wiring;

a second wiring intersecting three-dimensionally with said first wiring; and

a tunnel magnetoresistance element which is electrically connected to said first wiring through a switching element and is electrically connected to said second wiring and which is formed in the region of intersection of said first wiring and said second wiring such that a tunnel insulating layer is sandwiched between ferromagnetic materials which change in resistance depending on whether the spin direction is parallel or antiparallel, thereby recording information; wherein

said magnetic memory device comprises a magnetic

flux concentrator of high-permeability layer formed at least on both of the lateral sides of said first wiring and on the side of said first wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layer formed on the lateral sides of said first wiring projecting from said first wiring toward said tunnel magnetoresistance element.

15. The magnetic memory device as defined in Claim 14, wherein an insulating film is formed between the magnetic flux concentrator and the tunnel magnetoresistance element.

16. A nonvolatile magnetic memory device of the type having:

a first wiring;

a second wiring intersecting three-dimensionally with said first wiring; and

a tunnel magnetoresistance element which is electrically connected to said first wiring through a switching element and is electrically connected to said second wiring and which is formed in the region of intersection of said first wiring and said second wiring such that a tunnel insulating layer is sandwiched between ferromagnetic materials which change in resistance

depending on whether the spin direction is parallel or antiparallel, thereby recording information; wherein

said magnetic memory device comprises a magnetic flux concentrator of high-permeability layer formed at least on both of the lateral sides of said second wiring and on the side of said second wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layer formed on the lateral sides of said second wiring projecting from said second wiring toward said tunnel magnetoresistance element.

17. The magnetic memory device as defined in Claim 16, wherein the magnetic flux concentrator has the high-permeability layer formed also on the surface of the second wiring close to the tunnel magnetoresistance element.

18. The magnetic memory device as defined in Claim 16, wherein an insulating film is formed between the magnetic flux concentrator and the second wiring.

19. The magnetic memory device as defined in Claim 16, wherein the magnetic flux concentrator has the high-permeability layer formed, with an insulating film interposed, also on the surface of the second wiring close to the tunnel magnetoresistance element.

20. A method for producing a nonvolatile magnetic memory device by the steps of forming:

a first wiring;

a tunnel magnetoresistance element which has a tunnel insulating layer sandwiched between ferromagnetic materials and is electrically insulated from said first wiring; and

a second wiring which is electrically connected to said tunnel magnetoresistance element and intersects three-dimensionally with said first wiring, with said tunnel magnetoresistance element interposed; wherein

said method comprises a step of forming a magnetic flux concentrator of high-permeability layer at least on both of the lateral sides of said first wiring and on the side of said first wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layer formed on the lateral sides of said first wiring projecting from said first wiring toward said tunnel magnetoresistance element.

21. The method for producing a magnetic memory device as defined in Claim 20, wherein the high-permeability layer is formed also on the surface of the first wiring close to the tunnel magnetoresistance

element.

22. The method for producing a magnetic memory device as defined in Claim 20, wherein the high-permeability layer is formed, with an insulating film interposed, on the first wiring.

23. The method for producing a magnetic memory device as defined in Claim 22, wherein the high-permeability layer is formed, with an insulating film interposed, also on the surface of the first wiring close to the tunnel magnetoresistance element.

24. A method for producing a nonvolatile magnetic memory device by the steps of forming:

a first wiring;

a tunnel magnetoresistance element which has a tunnel insulating layer sandwiched between ferromagnetic materials and is electrically insulated from said first wiring; and

a second wiring which is electrically connected to said tunnel magnetoresistance element and intersects three-dimensionally with said first wiring, with said tunnel magnetoresistance element interposed; wherein

said method comprises a step of forming a magnetic flux concentrator of high-permeability layer at least on both of the lateral sides of said second wiring and on

the side of said second wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layer formed on the lateral sides of said second wiring projecting from said second wiring toward said tunnel magnetoresistance element.

25. The method for producing a magnetic memory device as defined in Claim 24, wherein the high-permeability layer is formed also on the surface of the second wiring close to the tunnel magnetoresistance element.

26. The method for producing a magnetic memory device as defined in Claim 24, wherein the high-permeability layer is formed, with an insulating film interposed, on the second wiring.

27. The method for producing a magnetic memory device as defined in Claim 26, wherein the high-permeability layer is formed, with an insulating film interposed, also on the surface of the second wiring close to the tunnel magnetoresistance element.

28. A method for producing a nonvolatile magnetic memory device by the steps of forming:

a first wiring;

a tunnel magnetoresistance element which has a

tunnel insulating layer sandwiched between ferromagnetic materials and is electrically insulated from said first wiring; and

a second wiring which is electrically connected to said tunnel magnetoresistance element and intersects three-dimensionally with said first wiring, with said tunnel magnetoresistance element interposed; wherein

said method comprises a step of forming, after forming said first wiring, a magnetic flux concentrator of high-permeability layer between said first wiring and said tunnel magnetoresistance element and on the lateral sides of said tunnel magnetoresistance element, with an insulating film interposed.

29. A method for producing a nonvolatile magnetic memory device by the steps of forming:

a first wiring;

a tunnel magnetoresistance element which has a tunnel insulating layer sandwiched between ferromagnetic materials and is electrically insulated from said first wiring; and

a second wiring which is electrically connected to said tunnel magnetoresistance element and intersects three-dimensionally with said first wiring, with said tunnel magnetoresistance element interposed; wherein

said method comprises the steps of forming:

a first magnetic flux concentrator of high-permeability layer at least on both of the lateral sides of said first wiring and on the side of said first wiring which is opposite to the side facing said tunnel magnetoresistance element; and

a second magnetic flux concentrator of high-permeability layer, after forming said first wiring, between said first wiring and said tunnel magnetoresistance element and on the lateral sides of said tunnel magnetoresistance element, with an insulating film interposed.

30. The method for producing a magnetic memory device as defined in Claim 29, wherein the high-permeability layer of the first magnetic flux concentrator is formed, with an insulating film interposed, on the first wiring.

31. The method for producing a magnetic memory device as defined in Claim 27, wherein at least either of the high-permeability layer of the first magnetic flux concentrator formed on the lateral sides of the first wiring projects from the first wiring close to the tunnel magnetoresistance element toward the tunnel magnetoresistance element.

32. The method for producing a magnetic memory device as defined in Claim 31, wherein the high-permeability layer of the first magnetic flux concentrator is formed, with an insulating film interposed, on the first wiring.

33. A method for producing a nonvolatile magnetic memory device by the steps of forming:

a first wiring;

a switching element on said first wiring;

a tunnel magnetoresistance element which has a tunnel insulating layer sandwiched between ferromagnetic materials and is connected to said first wiring through said switching element; and

a second wiring which is electrically connected to said tunnel magnetoresistance element and intersects three-dimensionally with said first wiring, with said tunnel magnetoresistance element interposed; wherein

said method comprises a step of forming a magnetic flux concentrator of high-permeability layer at least on both of the lateral sides of said first wiring and on the side of said first wiring which is opposite to the side facing said tunnel magnetoresistance element, with at least either of said high-permeability layers formed on both of the lateral sides of said first wiring projecting

from said first wiring toward said tunnel magnetoresistance element.

34. The method for producing a magnetic memory device as defined in Claim 33, wherein the high-permeability layer is formed also on the surface of the first wiring close to the tunnel magnetoresistance element.

35. A method for producing a nonvolatile magnetic memory device by the steps of forming:

a first wiring;

a switching element on said first wiring;

a tunnel magnetoresistance element which has a tunnel insulating layer sandwiched between ferromagnetic materials and is connected to said first wiring through said switching element; and

a second wiring which is electrically connected to said tunnel magnetoresistance element and intersects three-dimensionally with said first wiring, with said tunnel magnetoresistance element interposed; wherein

said method comprises a step of forming a magnetic flux concentrator of high-permeability layer at least on both of the lateral sides of said second wiring and on the side of said second wiring which is opposite to the side facing said tunnel magnetoresistance element, with

at least either of said high-permeability layers formed on both of the lateral sides of said second wiring projecting from said second wiring toward said tunnel magnetoresistance element.

36. The method for producing a magnetic memory device as defined in Claim 35, wherein the high-permeability layer is formed also on the surface of the second wiring close to the tunnel magnetoresistance element.

37. The method for producing a magnetic memory device as defined in Claim 35, wherein the high-permeability layer is formed, with an insulating film interposed, on the second wiring.

38. The method for producing a magnetic memory device as defined in Claim 37, wherein the high-permeability layer is formed, with an insulating film interposed, also on the surface of the second wiring close to the tunnel magnetoresistance element.